

MACRO- AND MICROMORPHOLOGICAL STUDY OF *ARTEMISIA VULGARIS* L. FAM. ASTERACEAE GROWING IN EGYPT

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ABSTRACT

The macro and micromorphology of the leaf, stem, flower, root and rhizome of *Artemisia vulgaris* L. are presented with the aim of finding their diagnostic characters by which the plant can be easily identified in both the entire and powdered form.

INTRODUCTION

Artemisia vulgaris L. (Mugwort) is an aromatic perennial herb, distributed worldwide. It is mostly native to temperate North America, Europe, some in South America and North Africa to Siberia. Three *Artemisia* species (*A. judaica* L., *A. scoparia* Waldst. & Kit. And *A. monosperma* Del.) were listed and recorded in flora of Egypt. Moreover, two more species (*A. vulgaris* L. and *A. verlotiorum* Lamotte.) were newly added to Genus *Artemisia* (Boulos, 2002).

Phytochemical studies of *Artemisia vulgaris* L. resulted in the isolation of sterols, triterpenes and flavonoids. Biological screening of total ethanolic extract of the aerial parts of the plant proved antibacterial (Singh *et al.*, 2002; Sura *et al.*, 2012), antifungal, analgesic, antiinflammatory and anticancer activities especially colon carcinoma (Rabe *et al.*, 2002).

In Iran the leaf anatomy of different *Artemisia* species was studied and the results showed that Leaf symmetry is very variable and the dorsiventral structure was only seen in *A. vulgaris* (Noorbakhsh *et al.*, 2008). The literature review showed no reports concerning the macro- and micromorphology of the wild plant growing in Egypt. The present work covers macro- and micromorphological study of the leaves, stem, flowers, rhizome and root with the aim of finding out the diagnostic features by

which the plant can be easily identified in both entire and powdered forms.

MATERIALS AND MATHODS

Plant material

Flowering and fruiting plant of *Artemisia vulgaris* L. was collected in the flowering and early fruiting stage on May 2013 from the plant growing wild in the irrigated canal bank, El-Qanater, Qalubiya, Egypt.

The identity was kindly verified by Prof. Dr. Abd el Halim Abd el Mogali Mohamed, Professor of Botany in Horticultural Research Institute, Dokki, Cairo, Egypt. Avoucher specimen was deposited in the Herbarium of Pharmacognosy Department, Faculty of Pharmacy, Zagazig University, Egypt. The plant material used for this study was either fresh or preserved in glycerin-alcohol mixture (1:1).

I. Macromorphology:

Artemisia vulgaris L. (Fig.1A&1B) is a perennial erect herb attaining 50 cm in height. The stem attains 0.6 cm at the base and 0.3 cm at the apex in diameter. It is erect, semiwoody and is typically branched at the upper part with reddish-purple shoots.

Leaves are simple, alternately arranged on the stem, petiolate, stipulate, 1-10 cm in length, 2-8 cm wide and have a distinctive aroma. Leaf is dark green in colour at its upper surface (Fig.1C), being slightly hairy. However, the lower surface (Fig.1D) is

whitish in colour since it is covered with silvery-white wooly hairs. The upper leaves of the shoot are simple, sessile, exstipulate, and smaller than the lower ones, lanceolate with entire margin. Leaf blades at the middle and lower portion of the shoot have highly dissected margins, pinnately lobed and the lobes are broadly lanceolate with acute apex. Leaves have aromatic odour and slightly bitter taste.

Rhizomes are light brown in color, up to 1 cm in diameter and 13 cm in length and typically branching at nodes. Rhizomes develop adventitious roots (Fig.1F) at the nodes to fix the plant in soil. Externally the root system is earthy brown in colour with rough touch. It has flexible fracture showing a yellow interior, possesses a faint slight odour and salty taste.

The flower head is a compact capitulum developed on a short or sessile peduncle and appears in clusters at the upper portion and the lateral branches of the main stem. Number of inflorescences is about 10-20 per branch and about 15-30 florets developed densely on the flower head. Capitula are very small 2.5-3 mm wide, surrounded by two series of lanceolate bracts known as phyllaries. Only tubular florets are present. At the bud stage they are green in colour.

The ray florets are absent, while disc florets at blooming are very small (inconspicuous), reddish or greenish yellow and bisexual at the center of each head but may occasionally be just female on the periphery. These florets are sessile, epigenous and actinomorphic. The Calyx is absent (El-sahhar *et al.*, 2010).

The Corolla is composed of five united tubular petals with five recurved lobes. It is valvate at its apex and its base and the median portion are narrow, while the top is the widest part of the corolla. The androecium consists of five stamens, epipetalous, alternating with the petals, with syngenesious anthers and free filaments. The

gynoecium is a compound pistil of two united carpels, uniloculate, ovule solitary, basal and inferior ovary with glandular hairs and bifid papillosed stigma.

II- Micromorphology:

1. The leaf

A transverse section of the leaf (Fig. 2A, 2B, 2C) shows a dorsiventral structure with one row of palisade under the upper epidermis, interrupted by collenchymatous cells in the midrib region. The midrib is more prominent on the lower surface and shows a parenchymatous cortex with subepidermal collenchyma and a stele formed a large central vascular bundle with two small lateral ones on each side. Each vascular bundle shows a pericycle formed of an upper and lower area of collenchymas; endodermis is well differentiated surrounding the vascular bundles. A number of schizogenous glands are present in the cortex.

Upper epidermis:

The upper epidermis (Fig. 3A) is formed of polygonal cells with sinuous anticlinal walls and is covered with thick smooth cuticle. They measure 26–45µm in length, 19 –33 µm in breadth and 11– 14 µm in height.

Lower epidermis:

The lower epidermis (Fig.3C) is formed of polygonal cells, the outer and inner tangential walls are very thick and cellulosic, with more sinuous anticlinal walls and covered with thick smooth cuticle. They measure 7– 39 µm in length, 4 –17 µm in breadth and 9– 22 µm in height.

Upper neural epidermis:

The upper neural epidermal cells (Fig. 3B) are polygonal, axially elongated with straight anticlinal walls and covered with moderately thick smooth cuticle. They measure 78 – 128 µm in length, 11 – 13 µm in breadth and 11 – 25 µm in height.

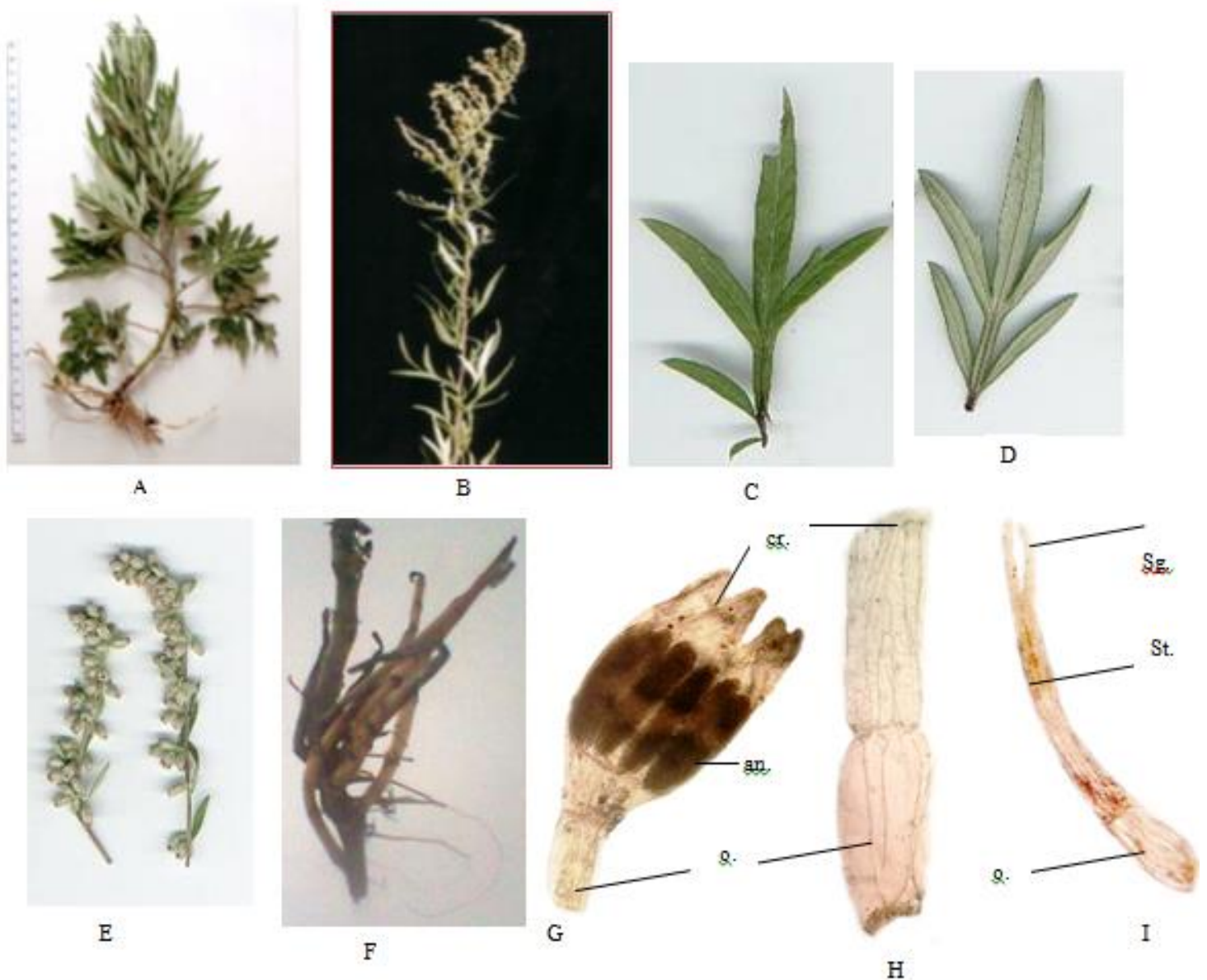


Fig. (1) Macromorphology of *Artemisia vulgaris* L.

- | | |
|---|---------|
| A. A photograph of the aerial parts. | (0.22X) |
| B. A photograph of the flowering aerial parts. | (0.34X) |
| C. A photograph of the upper surface of the leaf. | (1.3X) |
| D. A photograph of the lower surface of the leaf. | (1.3X) |
| E. A photograph of the inflorescence. | (0.16X) |
| F. A photograph of the root system. | (0.61X) |
| G. A photograph of the bisexual central floret. | (24.8X) |
| H. A photograph of the pistillate floret. | (44.4X) |
| I. A photograph of the carprl. | (39.5X) |
- an., anther; cr., corolla; o., ovary; sg., stigma st., style.

Lower neural epidermis:

The lower neural epidermal cells (Fig.3D) are polygonal, axially elongated cells with straight anticlinal walls and covered with thin smooth cuticle. They measure 67–250 μm in length, 9 – 22 μm in breadth and 11 – 28 μm in height. Both upper and lower epidermises of leaf midrib and lamina contain reddish brown content.

Mesophyll:

The mesophyll (Fig.2C) is dorsiventral with an upper palisade layer discontinuous in the midrib region and a moderately wide spongy tissue. The palisade (Fig. 2C) consists of one row of cylindrical, columnar and radially elongated cells with straight anticlinal walls and contains reddish brown content. The palisade tissue occupies about one-half of the whole thickness of the mesophyll. The cells measure 22–27 μm in length and 6 – 11 μm in diameter.

The spongy tissue (Fig.2C) is formed of 2 - 5 rows of thin walled, more or less rounded chlorenchymatous cells measuring 8.9 – 16.7 μm in diameter with wide intercellular spaces showing aerenchyma, and sometimes traversed by schizogenous gland.

Stomata:

Stomata are oval (Fig.3C) anisocytic or anomocytic type, present on both surfaces of the leaf and being numerous on the lower of the lamina and occasionally present in the neural surfaces. They measure 28 – 39 μm in length and 22 – 34 μm in breadth.

Glandular and non-glandular trichomes:

Upper and lower epidermises bear numerous non-glandular and few glandular trichomes.

A-Non-glandular trichomes: (Fig.3E)

1- T-Shaped (balanced hairs or two-armed hairs) where, they have a short straight or slightly curved uni-,bi-,tri- rarely multicellular uniseriate stalk and a horizontal usually twisted or curved end cell (the beam) and is covered with smooth

cuticle. The stalk measures 19–39 μm in length and 8 –20 μm in breadth. The beam measures 67– 318 μm in length and 6 – 17 μm in diameter at its widest part (Fig.3 E₁).

2- Dragger- shaped hair (Fig. 3E₂) is rarely present and consists of 1 to 4 short basal cells with a dragger-shaped apical end cells. The dragger- shaped hair measure 119-167 μm in length and 16 – 27 μm in diameter at its widest part (El-shabrawy, 1977).

B-Glandular trichome:

Compositae glandular hair: (Fig. 3G) is formed of a short stalk and nearly globular head. The stalk is bicellular, biseriate and measuring 7.8– 11.17 μm in length and 5.6 – 11.17 μm in width. The head is multicellular biseriate consisting of 4-8 cells arranged in two parallel rows and is covered by a thin cuticle. It measures 33 –39 μm in length and 28 – 32 μm in diameter at its widest part.

Midrib: (Fig. 2A)

The cortical tissue is formed of rounded or polyhedral thin- walled parenchymatous cells with narrow intercellular spaces and of 3 to 4 rows of peripheral thick walled collenchyma.

A number of schizogenous ducts 17.1 – 40.6 μm in diameter are occasionally scattered in the cortex. Calcium oxalate mostly rosette crystals are present also in the cortex.

The endodermis:

The endodermis is well differentiated around the large vascular bundle and consists of single row of tangentially elongated parenchymatous cells which free from starch granules.

The pericycle: (Fig. 2B)

The pericycle is formed of upper (5 – 7 rows) and lower (4–6 rows) of collenchymatous cells having shining cellulosic walls and enclosing the vascular bundles.

The vascular tissue: (Fig. 2A)

The vascular tissue in the wild plant is different from the cultivated plant. In the wild plant the vascular tissue consists

of one large central vascular bundle and smaller one at each side, while the cultivated plant showed only one central vascular bundle. The vascular bundle is formed of radiate xylem outward and phloem inward.

The xylem (Fig. 2B) is radiated and formed of lignified vessels and lignified wood parenchyma.

The vessels (Fig. 3F) are annular or spiral and measure 4.5 – 22.3 μ in diameter.

Table 1: The microscopical numerical values of the leaves of *A. vulgaris* L.

Measured tissue	Numerical value
1-Stomatal Index	
a- Upper epidermis	10 – 15
b- Lower epidermis	27 –34
2-Vein-Islet Number	15 –17
3-Veinlet-Termination Number	14 –23
4-Palisade Ratio	3.5 –6.2

2- The petiole

A transverse section of the petiole (Fig.4A & 4B) is biconvex in outline showing two wings from upper corners each has additional small bundle embedded in its ground tissue. It shows an outer epidermis surrounding a cortex formed of an outer collenchymas and inner parenchyma. The vascular system consists of central arc of a main vascular bundle and three lateral ones on sides in addition to one smaller vascular bundle in each wing.

The epidermis

The epidermal cells (Fig.5A) are polygonal, with straight, thin cellulosic anticlinal walls covered with thin to moderately thick cuticle. The cells measure 55.9 – 100.6 μ m in length, 11.17 – 16.75 μ m in breadth and 10 – 14.5 μ m in height. Both upper and lower epidermal cells contain reddish brown content.

The stomata are similar to that of the leaf but, they measure 24 –35 μ m in length and 20–34 μ m in breadth.

Trichomes:

Non- glandular and few glandular trichomes (Fig.5C &5D) were recorded in

The phloem (Fig. 2B) is composed of polygonal thin-walled cellulosic elements, differentiated into sieve tubes, companion cells and phloem parenchyma.

The microscopical numerical values of the leaf:

Stomatal index, vein-islet number, veinlet termination number and palisade ratio are summarized in Table 1.

the petiole and similar to that present in the leaf.

The midrib:

The cortical tissue (Fig.4A&4B) is parenchymatous with a continuous layer of 2–3 rows of collenchyma cells below the epidermises. The collenchymatous cells have moderately thick cellulosic walls and measure 11.17 – 22.3 μ m in diameter. The rest of the cortex is parenchymatous consisting of more or less rounded cells with thin cellulosic walls and narrow intercellular spaces measuring 16.75– 41.3 μ m in diameter. Rosette crystals of calcium oxalate (Fig.5 E) were detected in the collenchymatous and the parenchymatous regions measuring 8.3 -13.6 μ in diameter.

The endodermis is more distinguishable above the vascular bundles. It consists of a single row of more or less rounded to large tubular thin walled cells and 0.7 – 13.4 μ m in diameter. The pericycle region is similar to that in the leaf.

The vascular tissue:

The central vascular arc and the lateral bundles have similar structure. Each is formed of collateral vascular bundles with

lower phloem and upper xylem. The phloem is composed of polygonal thin walled cellulosic elements. The xylem (Fig.4A& 4B) is formed of moderately thick walled

lignified spiral vessels (Fig.5B) measuring 5.58 – 11.17 µm in diameter and cellulosic wood parenchyma

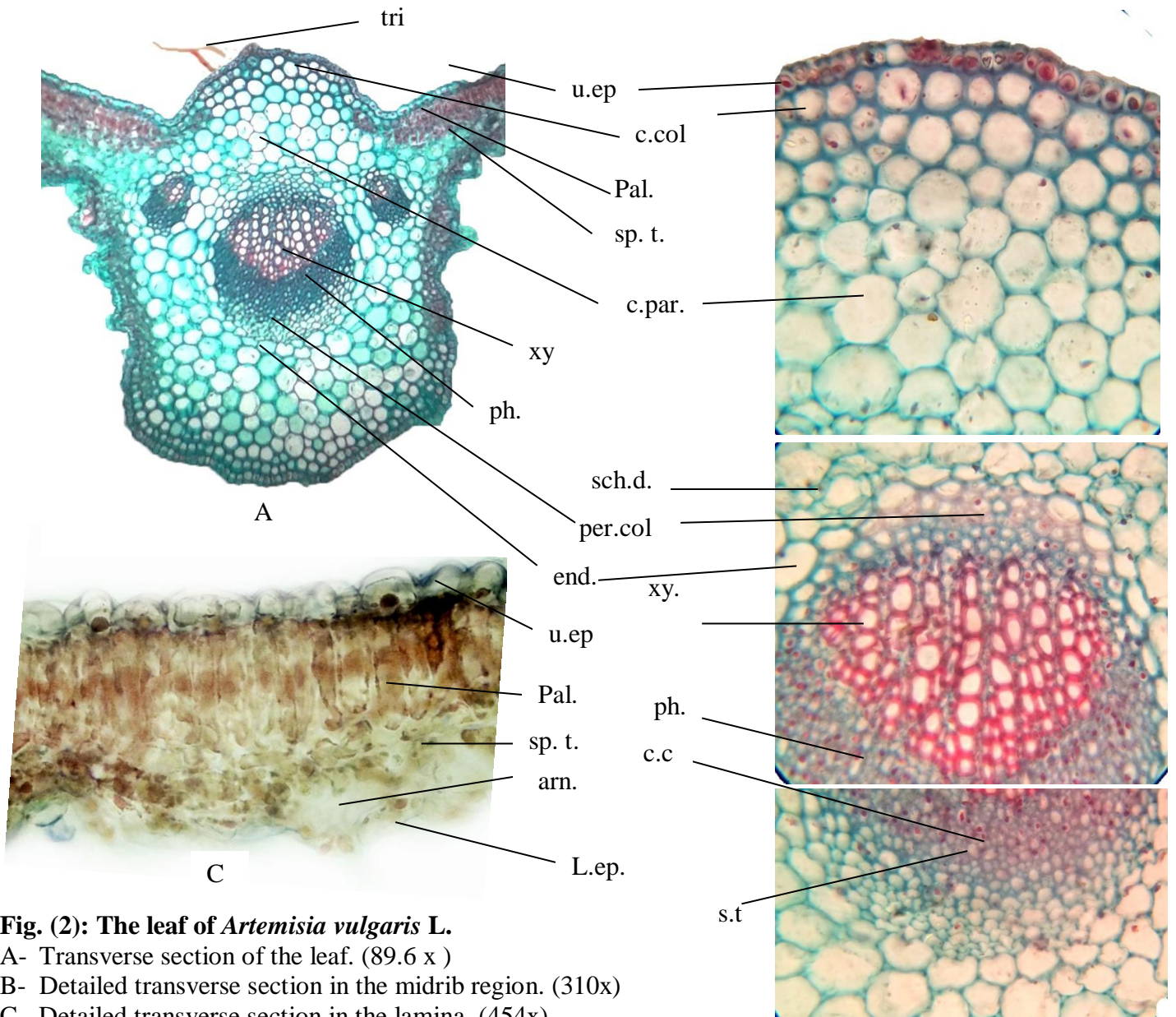


Fig. (2): The leaf of *Artemisia vulgaris* L.

A- Transverse section of the leaf. (89.6 x)
 B- Detailed transverse section in the midrib region. (310x)
 C- Detailed transverse section in the lamina. (454x)
 arn., aerenchyma; c.c., companion cell; c.co., cortical collenchymas; c. par., cortical parenchyma; end., endodermis; l.ep., lower epidermis; pal., palisade; per.col., pericyclic collenchymas; ph., pbloem; sch.d., schyzogenous duct; sp.t., spongy tissue; s.t., sieve tube; tri., trichome; u.ep., upper epidermis; xy., xylem

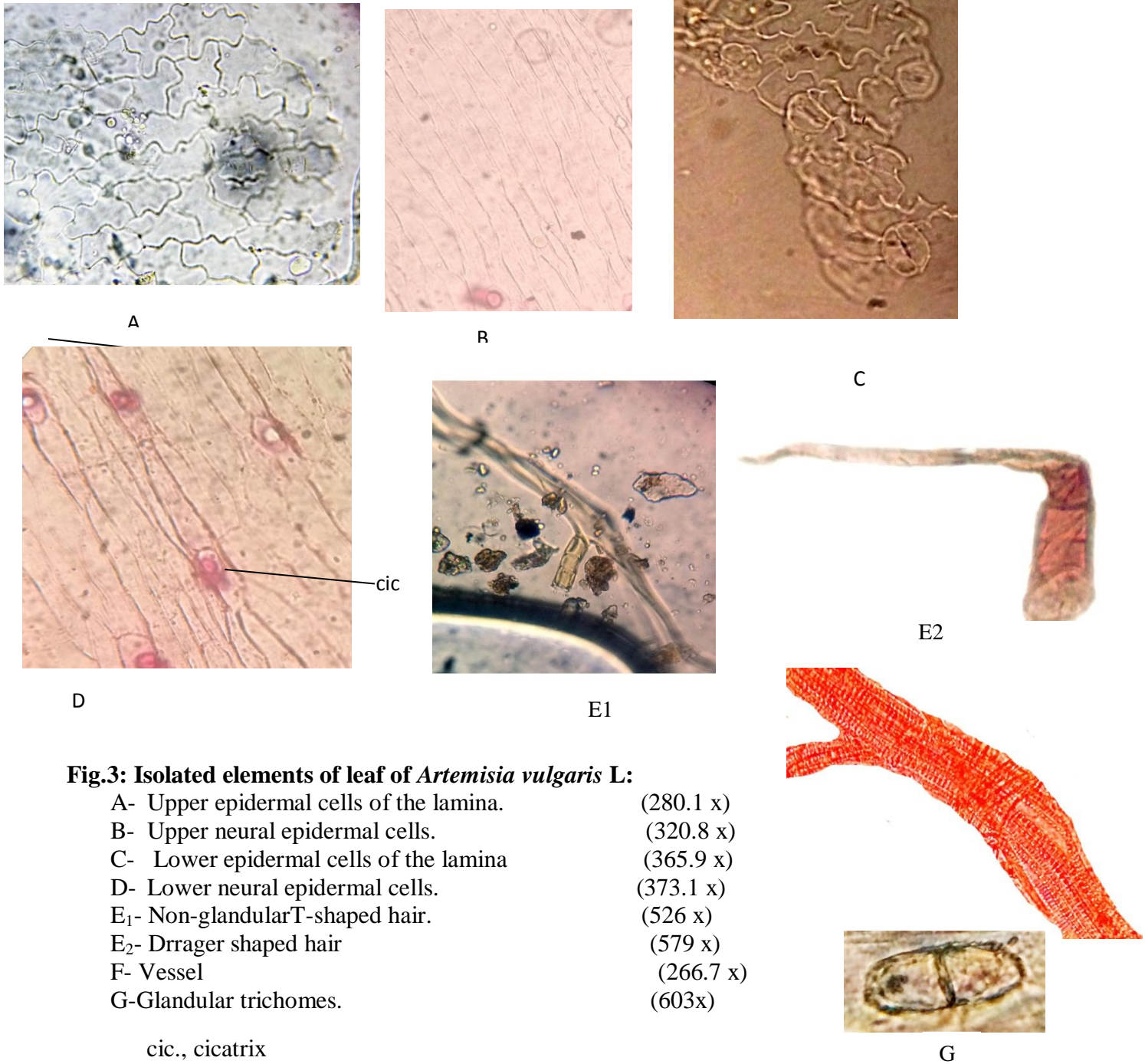


Fig.3: Isolated elements of leaf of *Artemisia vulgaris* L:

- A- Upper epidermal cells of the lamina. (280.1 x)
- B- Upper neural epidermal cells. (320.8 x)
- C- Lower epidermal cells of the lamina (365.9 x)
- D- Lower neural epidermal cells. (373.1 x)
- E₁- Non-glandular T-shaped hair. (526 x)
- E₂- Dragger shaped hair (579 x)
- F- Vessel (266.7 x)
- G- Glandular trichomes. (603x)

cic., cicatrix

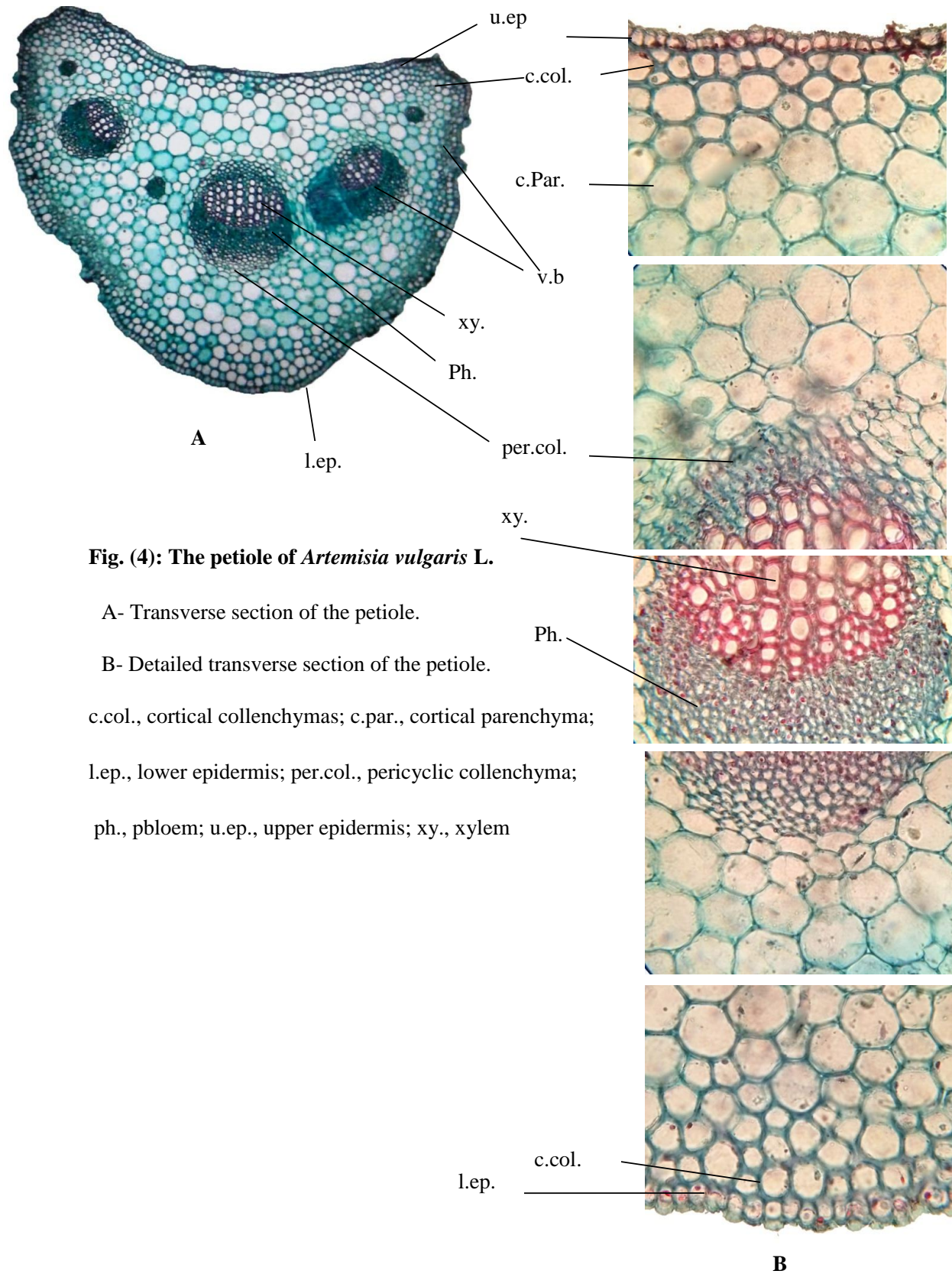


Fig. (4): The petiole of *Artemisia vulgaris* L.

A- Transverse section of the petiole.

B- Detailed transverse section of the petiole.

c.col., cortical collenchymas; c.par., cortical parenchyma;

l.ep., lower epidermis; per.col., pericyclic collenchyma;

ph., phloem; u.ep., upper epidermis; xy., xylem

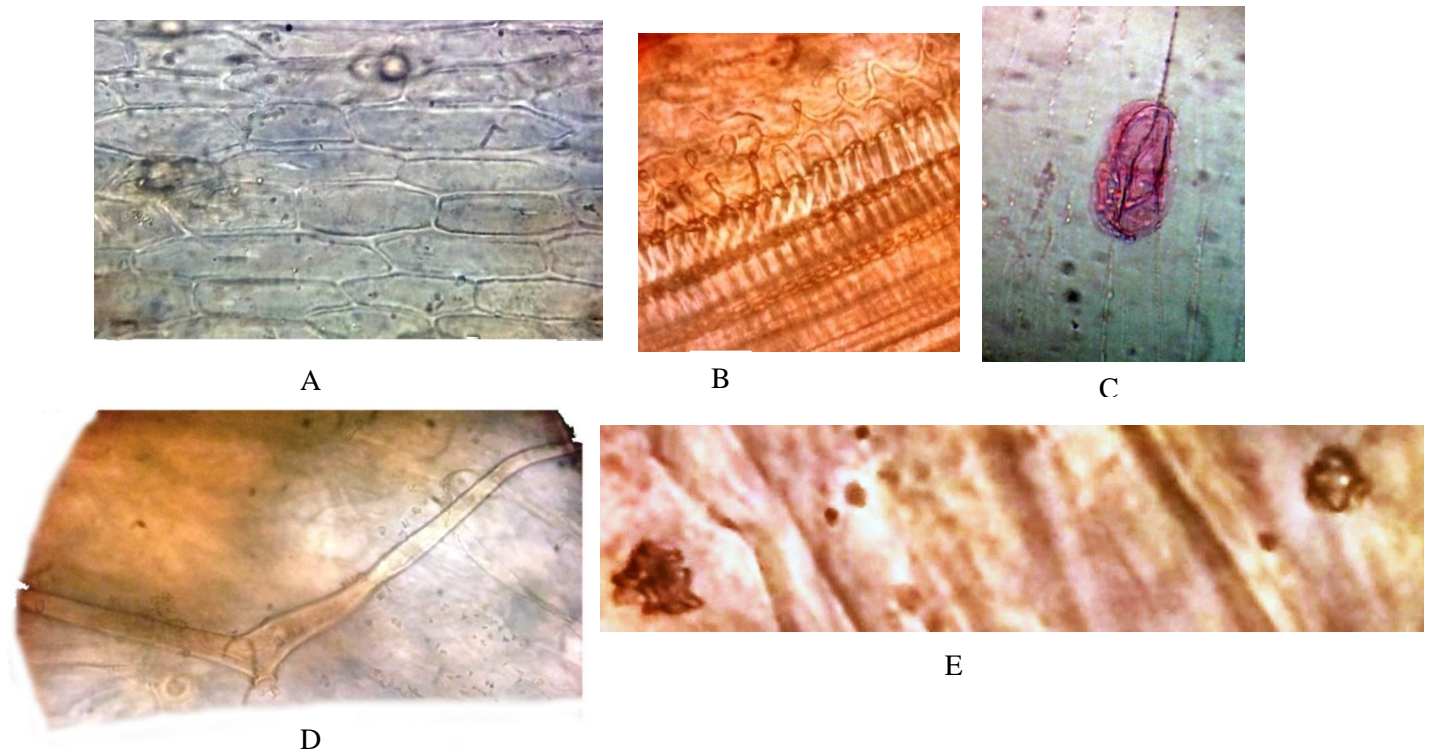


Fig. (5): The powdered petiole of *Artemisia vulgaris* L.

- | | |
|----------------------------|----------|
| A- The epidermal cells | (570x) |
| B- Xylem vessels | (340x) |
| C- Glandular trichomes | (727.2x) |
| D- Non-glandular trichomes | (299.4x) |
| E-Ca.oxalate crystal | (1123X) |

The powdered leaf and petiole:

The powdered leaf is green in colour with aromatic odour and slightly bitter taste. It is characterized microscopically by the following fragments:

1. Fragments of upper epidermis of the lamina; showing polygonal cells with straight anticlinal walls, covered with smooth cuticle and showing anomocytic stomata.
2. Fragments of lower epidermis of the lamina showing polygonal cells with wavy anticlinal walls, covered with thick cuticle and anomocytic stomata.
3. Fragments of upper and lower epidermises of the midrib showing polygonal, axially elongated cells with straight anticlinal walls and covered with thin smooth cuticle.
4. Numerous non-glandular trichomes of T-shaped type with short unicellular or multicellular stalk and single beam cell which are sometimes seen detached from its stalk.
5. Few glandular trichomes of compositous type with biseriate, bicellular stalk and biserriate, multicellular head.
6. Fragments of lamina showing palisade cells and spongy parenchyma cells.

7. Fragments of broken narrow spiral, annular and reticulate vessels.
8. Rosettes of calcium oxalate are present.

3- The old stem:

A transverse section of the old stem (Fig 6A & 6B) is circular in outline and consists of an outer cork followed by phellogen and narrow phelloderm. The endodermis is well differentiated. It followed by pericycle which represented by a discontinuous ring of lignified fibers separated by parenchyma. The vascular tissue consists of a ring of 12 - 14 collateral vascular bundles radially arranged around wide parenchymatous pith in the center.

The cork:

The cork (Fig. 6C) is formed of 3 to 4 radially arranged rows of tangentially elongated cells with subridged and slightly lignified walls measuring 39.1 to 61.5 μm in length, 16.7 - 27.9 μm in breadth and 9 - 13 μm in height. In surface view, the cells are polygonal with straight anticlinal wall.

The phelloderm:

The phelloderm (Fig.6B) is formed of 6-8 rows of parenchymatous cells with thin-cellulosic walls and narrow intercellular spaces. They measure 22.34– 25.6 μm in diameter. Several Schizogenous glands form diffuse ring outside the endodermis. They are rounded or oval in outline measuring 29 – 38 μm in diameter and filled with dark content. The endodermis (Fig. 6A&6B) is well differentiated and consists of thin-walled, axially elongated parenchymatous cells surrounding the pericycle, which measure 12.3 -17.9 μm in diameter.

The pericycle:

The pericycle is composed of discontinuous ring of lignified fibers which

are fusiform with moderately thick, pitted lignified walls, wide lumen and acute or acuminate apex and measure 650.6 – 924.6 μm in length and 5.6 –12.3 μm in diameter.

Vascular tissue:

The vascular tissue is formed of 12 – 14 unequal, collateral vascular bundles arranged in a ring and separated by wide medullary rays. Each vascular bundle consists of xylem in word, phloem outward and cambium in between.

The phloem:

The phloem is formed of thin walled cellulosic elements followed by cambium.

The cambium:

Cambium is distinguishable and represented by 3-4 rows of tangentially elongated, radially arranged, thin-walled meristematic cells having a brick-like arrangement and measure 6.7 – 11.17 μm in diameter.

The xylem:

Xylem consists mainly of vessels, numerous wood fibers and wood parenchyma. The vessels (Fig.6E) are radially arranged, few are solitary, have spiral, annular and pitted thickening and measure 8.9 – 16.8 μm in diameter. The wood fibers (Fig. 6D) are spindle-shaped with thick, pitted lignified walls, narrow lumen and blunt apices. They measure 787.6 - 1575 μm in length and 5.6 –10.1 μm in diameter. The wood parenchyma (Fig. 6F) consist of polygonal, rectangular usually axially elongated cells with slightly lignified, thick pitted walls, showing simple pits and measure 8.9 – 12.3 μm breadth. The pith is wide formed of rounded or oval usually isodiametric parenchymatous cells, contain rosettes of calcium oxalate crystals measuring 5.6-11.4 μm in diameter.

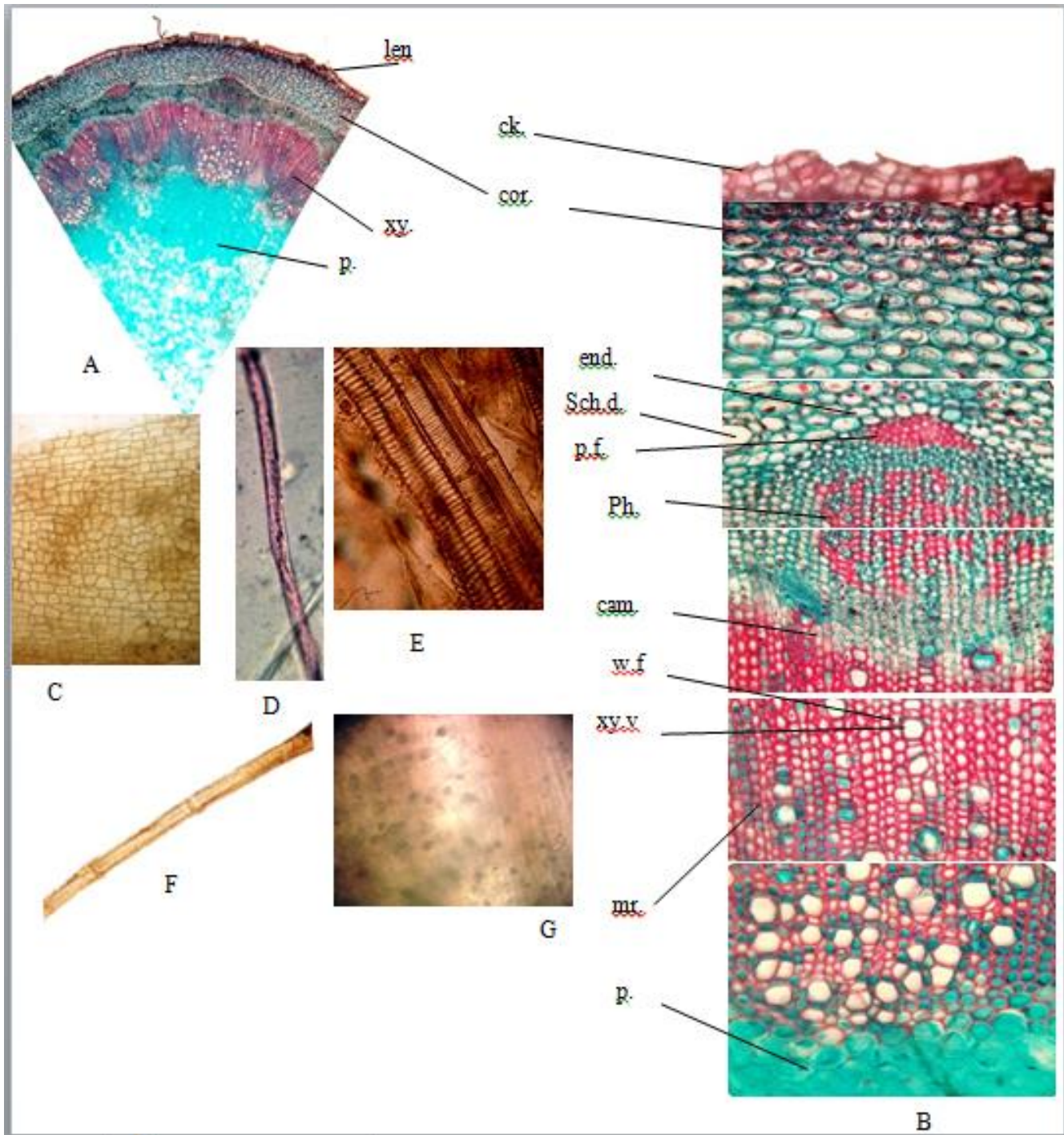


Fig. (6): The old stem of *Artemisia vulgaris*.

A-Transverse section of the old stem (198.4 x)

B- Diagrammatic transverse section of the old stem (47.6 x)

C-Cork (81.3 x)

D- Fiber (78.2x)

E-Xylem vessel (297.8 x)

F- Wood parenchyma (243.9 x)

G- Ca oxalate rosettes (350.8 x)

cam., cambium; end., endodermis; len., lenticle; mr., medullary ray; par., parenchyma;

p.f., pericyclic fibers; ph., phloem; p., pith; sch.d., schyzogenous duct;w.f., wood fiber ; xy.v., xylem vessel.

The powdered stem:

The powdered stem is yellowish in colour with faint characteristic odour and slightly bitter taste. It is characterized microscopically by the presence of the following fragments:

1. Polygonal, rectangular cork cells.
2. Fragments of lignified fusiform pericyclic fibers with moderately thick, pitted lignified walls, wide or narrow lumen and acute, rounded or acuminate apex.
3. Fragments of lignified spiral, annular and pitted vessels.
4. Fragments of pitted wood parenchyma which is polygonal, rectangular usually axially elongated cells with slightly thick lignified, thick pitted walls and showing simple pits
5. Fragments of spindle-shaped wood fibers with a very thick, pitted lignified walls, narrow lumen and blunt apices.
6. Rosettes of calcium oxalate crystals are present.

4-The inflorescence: (Fig. 1E)

The bract

Transverse sections of the outer and inner bracts are similar and slightly convex in shape (Fig.7A). The midrib is project slightly in the outer surface and traversed by

avascular strands formed of small xylem vessels. The lamina on both sides of the midrib is traversed by bands of sclerenchymatous fibers.

Epidermis:

The epidermal cells of the apical part on both sides (Fig. 7- B₁ and C₁) are axially elongated, thin walled and covered with smooth cuticle. They have wavy anticlinal walls. Some cells are protruding to form covering trichomes.

The marginal epidermal cells on both sides (Fig. 7- B₂ and C₂) are axially elongated cells with thin wavy anticlinal walls and covered with thin smooth cuticle.

At the middle epidermal cell on both sides (Fig. 7- B₃ and C₃) are axially elongated, polygonal in shape, with straight anticlinal walls. They are covered with thick smooth cuticle.

At the base The cells of both epidermises (Fig. 7- B₄ and C₄) are polygonal, subrectangular having slightly sinuous anticlinal walls. They are covered with thick striated cuticle. The elliptical or rounded anomocytic stomata (Fig.7D) are numerous in the outer epidermis only and measured 16.8 –22.3 µm in length and 8.9 – 16.7 µm in breadth.

The cell dimensions (in micron) of both epidermises of different parts of the outer bracts are shown in Table 2.

Table 2: Epidermal cells dimensions (in micron) of the bract

Epidermis	Outer epidermis			Inner epidermis		
	Length	Breadth	Height	Length	Breadth	Height
At the apex	40.3- 82.35	7.8- 13.2	5.6- 8.9	37.9- 72.6	7.8- 11.17	5.6- 8.9
At the margin	27.93- 83.8	5.6 -13.4	5.6 - 8.9	31.2- 125	6.25- 25	5.6- 8.9
At the middle	61.5–122.9µ	11.17- 14.5	7.25- 8.3	37.3- 102.5	6.4 - 13.3	7.25- 8.3
At the base	13.4- 44.6	10.05-16.5	6.5- 8.3	32.4.- 41.34	20.11- 27.9	6.5- 8.3

The trichomes are similar to those of the leaf, being of the glandular compositous and non- glandular T-shaped trichomes. They are present on the outer surface only.

The mesophyll (Fig.7A) is not differentiated into classical palisade cells and spongy tissues, while it is mainly composed of parenchyma cells traversed by sclerenchymatous fibers having thick lignified pitted walls and slightly pointed or rounded ends.

The midrib:

The cortical tissue of the midrib adjacent to the upper epidermis consists of 3-4 rows of thin- walled ovoid parenchyma cells showing a schizogenous gland nearly above the vascular strand and it is rounded in shape measuring 8.9 – 14.5 μm in diameter. In addition, the cortical tissue adjacent to the lower epidermis consists of 1-2 rows of rounded parenchyma cells. The vascular bundle (Fig.7A) is collateral, composed of few delicate xylem vessels showing spiral, reticulate, scleriform or pitted thickening. Thin walled phloem and parenchymatous pericycle are present.

The Floret

I- The Calyx: is absent.

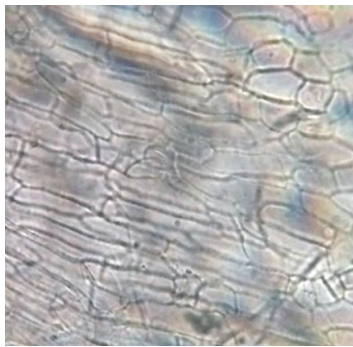
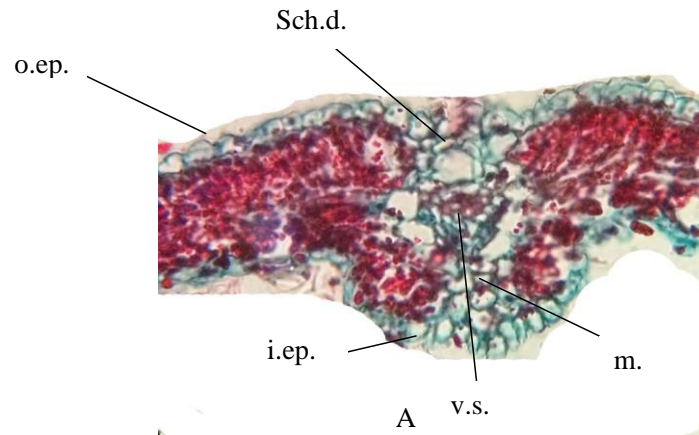
II- The Corolla:

A transverse section in the petals (Fig.8A) showing an inner and outer epidermises enclosing in between a narrow homogenous mesophyll transversed longitudinally by a collateral vascular strands composed of xylem and phloem underneath.

The outer epidermal cells (Fig. 8B) are isodiametric or slightly elongated cells with straight or slightly wavy anticlinal wall, covered with smooth cuticle and have anomocytic stomata and glandular and non-glandular trichomes (Fig. 8D). They measure 35.7 to 89.3 μ in length, 3.6 to 12 μ in breadth.

The inner epidermal cells (Fig.8C) are formed of slightly elongated cells with straight or slightly wavy anticlinal walls and covered with smooth cuticle. They measure 30.1 to 78.2 μ in length, 4.4 to 10 μ in breadth. Stomata and trichomes are absent.

The mesophyll is homogenous consists of 2 to 3 layers of rounded or oval, thin walled parenchymatous cells showing a schizogenous gland nearly above the vascular strand which consists of a few narrow, lignified, spirally thickened vessels and small band of phloem elements.



B₁



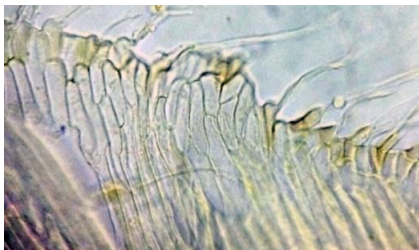
B₂



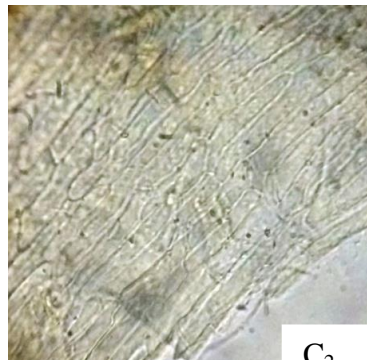
B₃



B₄



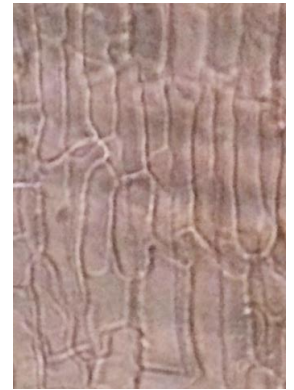
C₁



C₂



C₃



C₄

Fig. (7): The bract of *Artemisia vulgaris* L.:

A- Transverse section of the bract. (482.7 x)

B- Outer (lower) epidermis of the bract.

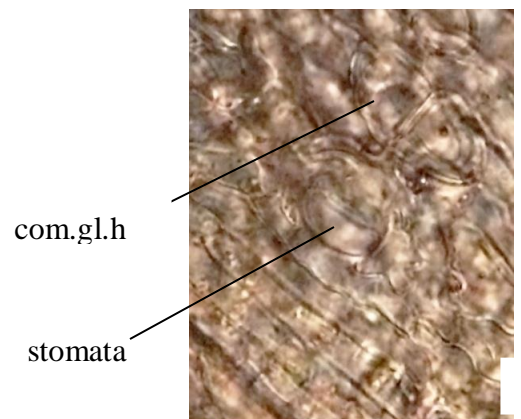
B₁- Near the apex. (124.06 x)

B₂- Near the margin. (238 x)

B₃- At the middle. (642.3 x)

B₄- Near the base. (297.6 x)

C- Inner (upper) epidermis of the bract.



D

C ₁ - Near the apex.	(214.2 x)
C ₂ - Near the margin.	(233 x)
C ₃ - At the middle.	(244 x)
C ₄ - Near the base.	(308.6 x)

D- Epidermal cell with stomata and glandular trichome (672.6 x)
com.gl.h.,compositae glandular hair; i.ep., inner epidermis; m., mesophyll; o.ep., outer epidermis; sch.d., schizogenous duct; st. stomata.

II- The Corolla:

A transverse section in the petals (Fig.8A) showing an inner and outer epidermises enclosing inbetween a narrow homogenous mesophyll transversed longitudinally by a collateral vascular strands composed of xylem and phloem underneath.

The outer epidermal cells (Fig. 8B) are isodiametric or slightly elongated cells with straight or slightly wavy anticlinal wall, covered with smooth cuticle and have anomocytic stomata and glandular and non glandular trichomes (Fig. 8D). They measure 35.7 to 89.3 μ in length, 3.6 to 12 μ in breadth.

The inner epidermal cells (Fig.8C) are formed of slightly elongated cells with straight or slightly wavy anticlinal walls and covered with smooth cuticle. They measure 30.1 to 78.2 μ in length, 4.4 to 10 μ in breadth. Stomata and trichomes are absent.

The mesophyll is homogenous consists of 2 to 3 layers of rounded or oval, thin walled parenchymatous cells showing a schizogenous gland nearly above the vascular strand which consists of a few narrow, lignified, spirally thickened vessels and small band of phloem elements.

III- The Androecium

1- Filament:

The transverse section of the filament (Fig. 9A) shows an epidermis surrounding a parenchymatous ground tissue which is traversed by central small vascular strand.

Epidermis:

The epidermal cells are rectangular and covered with thin cuticle. They have straight anticlinal walls, measuring 78 – 122.6 μ m in

length, 11 – 17.8 μ m in breadth and lack to the presence of stomata.

Ground tissue:

The ground tissue (Fig.9A) consists of 2 to 3 rows of thin-walled cellulosic loosely arranged parenchymatous cells traversed longitudinally by a central vascular strand showing few delicate spiral vessels and cellulosic thin-walled phloem elements.

2- Anther:

A transverse section of the anther (Fig. 9B) formed of two anther lobes separated by the connective; each lobe encloses two pollen sacs containing pollen grains. The anther wall (Fig. 9B) is formed of an epidermis underlined by a fibrous layer. The fibrous layer is made up of one row of radially elongated cells having lignified bar like thickening. Stomata and trichomes are completely absent. The pollen grains (Fig.9D) are spherical, yellow, having 3 germ pores and 3 germ furrows with smooth exine. It measures 16.7 - 27.9 μ m in length and 11.17 - 22.4 μ m in width.

IV- The gynaecium:

1- Stigma:

The transverse section of stigma lobe (Fig.10A and10 E) is formed of papillosed epidermis enclosing a ground tissue which is traversed longitudinally by a secretory duct and a small vascular strand.

Epidermis:

The epidermis (Fig.10A and10E) is formed of polygonal thin walled, axially elongated cells with straight anticlinal walls and covered with thin smooth cuticle; the outer periclinal walls of the cells are prolonged outward into long conical papillae

with acute or sub-acute apices. It measures 55.8 – 78.2 μm in length and 4.7– 11.2 μm breadth. Stomata and trichomes are absent.

2- Style:

The transverse section of style (Fig. 10B and 10F) shows an epidermis formed of rectangular, axially elongated cells with straight anticlinal walls and covered with thin smooth cuticle. The epidermis measures 50.2 - 106.1 μm in length and 7.8-11.3 μm in breadth.

3- Ovary

The transverse section of the ovary (Fig.10 C and D) is oval in shape with one

locule and basal placentation. It consists of an outer and inner epidermises enclosing a parenchymatous mesophyll, and is traversed by numerous narrow vasocentric vascular strand.

The epidermis consists of polygonal cells with thin straight anticlinal walls and is covered with thin smooth cuticle. It measure 8.9 to 25.6 μm in length and 5.6 to 11.4 μm in breadth.

Trichomes are numerous on the epidermis. They are of the glandular coppositous type (Fig.10G). Stomata are absent.

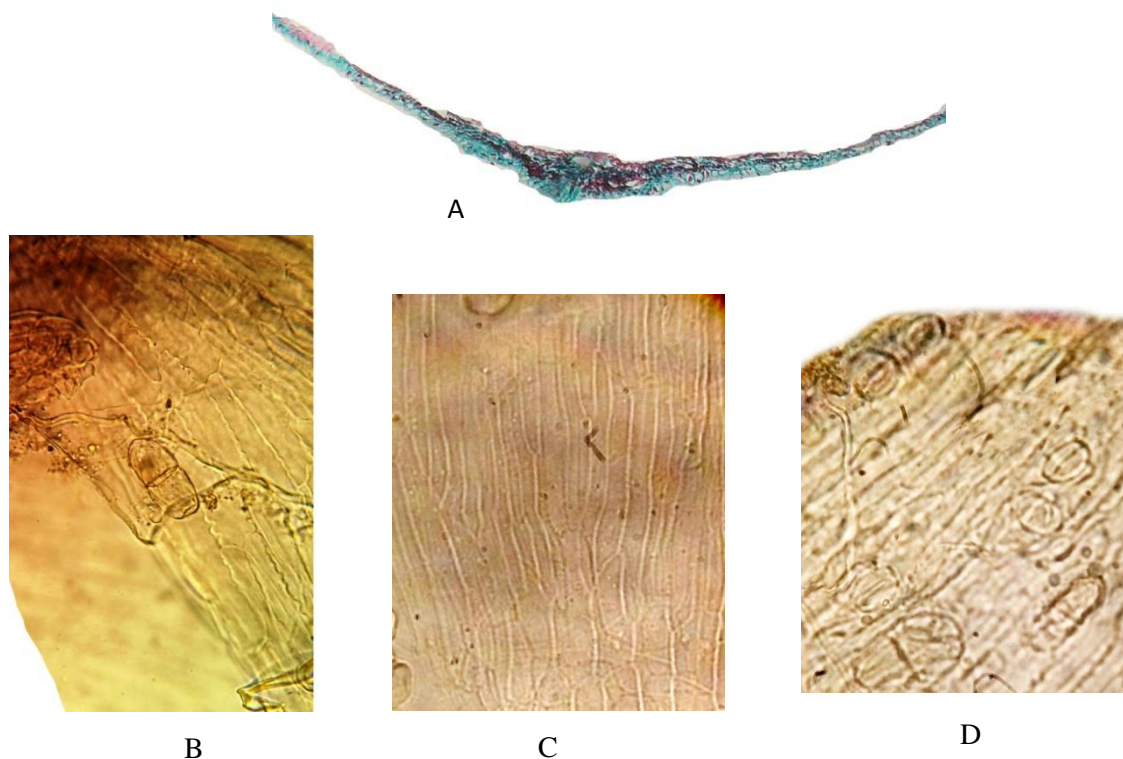


Fig. (8) The corolla:

- A. A photo of transverse section of the corolla (149.2x)
- B. A photo of the outer epidermis of the corolla (336.3x)
- C. A photo of the inner epidermis of the corolla (298.5x)
- D. A photo of the glandular trichome with stomata (336.3x)

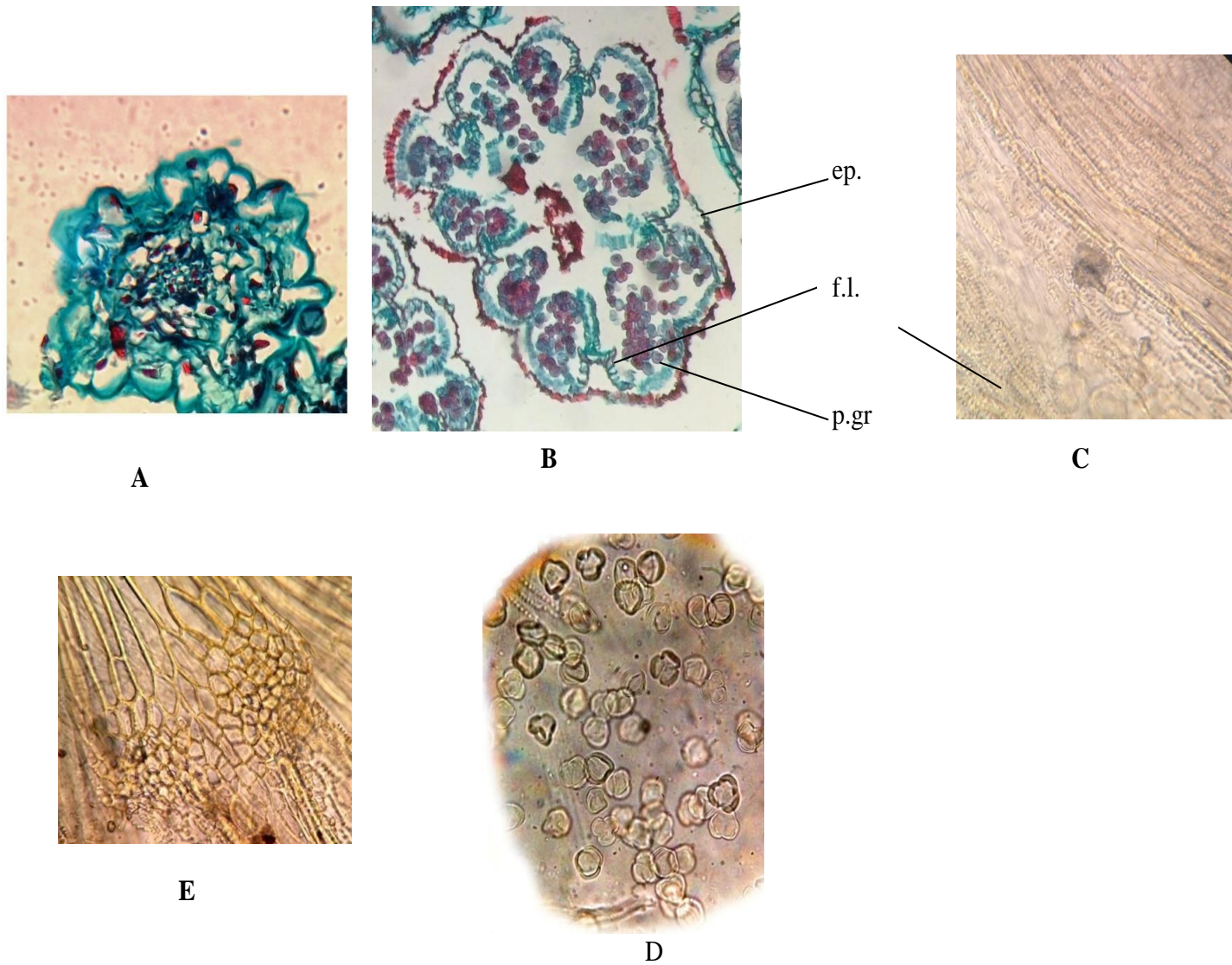


Fig. (9) The androecium:

- A- Transverse section of the filament. (358.1x)
- B- Diagrammatic transverse section of the anther. (89.7x)
- C- Fibrous layer in surface view. (250.8x)
- D- Pollen grains (179.2 x)
- E- The tip of the anther lobe. (145x)

c., connective; ep., epidermis; f.l., fibrous layer; p.gr, pollen grain

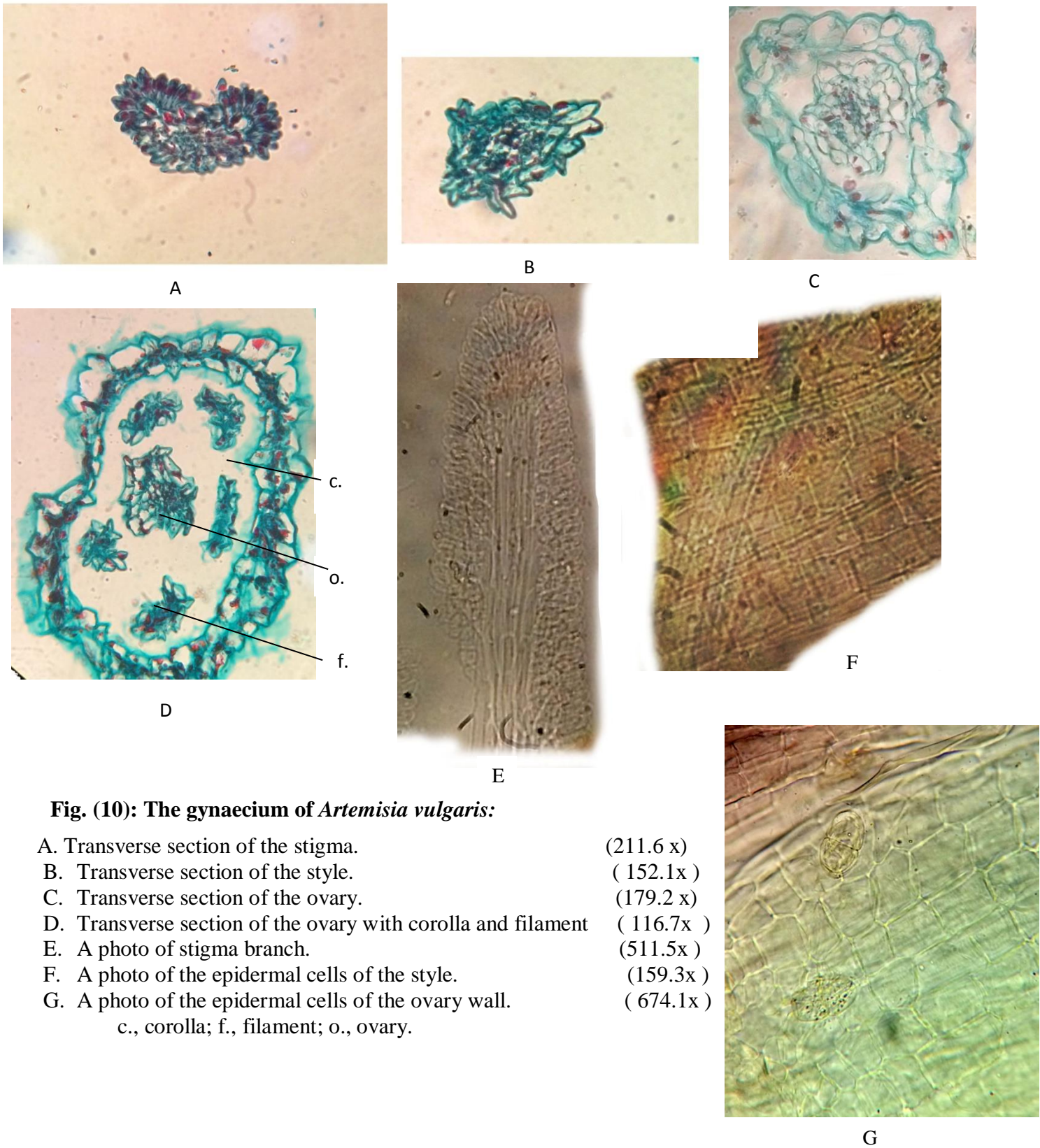


Fig. (10): The gynaecium of *Artemisia vulgaris*:

- A. Transverse section of the stigma. (211.6 x)
 - B. Transverse section of the style. (152.1x)
 - C. Transverse section of the ovary. (179.2 x)
 - D. Transverse section of the ovary with corolla and filament (116.7x)
 - E. A photo of stigma branch. (511.5x)
 - F. A photo of the epidermal cells of the style. (159.3x)
 - G. A photo of the epidermal cells of the ovary wall. (674.1x)
- c., corolla; f., filament; o., ovary.

5-The Peduncle

A transverse section of the peduncle (Fig.11A) is angular in outline with 5 ridges. It shows an outer epidermis enclosing a parenchymatous cortex with peripheral collenchyma and well differentiated endodermis followed by a ring of 6 – 8 separated vascular bundles within the pericycle. The vascular bundles are arranged in a ring surrounding a hollow central pith.

Epidermis:

The epidermis (Fig.11B) consists of rectangular or polygonal axially elongated cells with straight anticlinal walls covered with smooth cuticle and measure 55.8 -94.9 μm in length and 7.8- 16.5 μm in breadth.

Stomata:

Anomocytic stomata are present and measure 16.7 -22.3 μm in length and 16.7 - 22.3 μm in breadth.

Trichomes:

The glandular and non- glandular T- shaped type trichomes are commonly present (Fig. 11C), resembling those of the stem.

Cortex:

The cortex (Fig.11A) is comparatively narrow composed of thin walled, ovoid parenchymatous cells containing starch granules and measure 2.2-8.9 μm in diameter and calcium oxalate crystals measure 4.7-11.9 μm in diameter. The innermost layer consists of an endodermis resembling that of the stem.

Pericycle:

The pericycle (Fig.11A) consists of groups of pericyclic fibers capping the vascular bundles. The fibers are lignified with thick walls showing simple pits, narrow lumen and pointed ends. They measure 67.4 -104.2 μm in length and 1.8 - 3 μm in diameter.

Vascular tissue

The vascular tissue is formed of a ring of 6- 8 open collateral vascular bundles separated from each other by medullary rays 2-3 cells wide. Each vascular bundle is formed of an outer phloem and inner xylem. The phloem consists of thin walled cellulosic elements. The xylem is formed of lignified vessels (Fig.11D) and cellulosic wood parenchyma. The vessels are pitted or spiral in thickening and measure 3.35 - 7.8 μm in diameter.

The pith:

The pith is narrow, formed of rounded usually isodiametric parenchymatous cells.

The Powdered flower heads:

The powdered flower heads is yellowish-green in colour with slight aromatic odour and slight bitter taste. It is characterized by the following microscopical fragments:

1. Numerous non-glandular T-shaped hairs from the involucre bracts.
2. Numerous shining glandular trichomes of the compositous type, appearing in top and side views attached to fragments of epidermises.
3. Fragments of the filaments showing elongated epidermal cells with straight anticlinal walls.
4. Fragments of fibrous layer of the anther with bar-like thickening which appear as beads in surface view.
5. Fragments of style showing epidermal cells with rectangular elongated cells with straight anticlinal walls and covered with smooth cuticle.
6. Fragments of stigma showing papillosed epidermal cells.
7. Fragments of narrow lignified spiral vessels

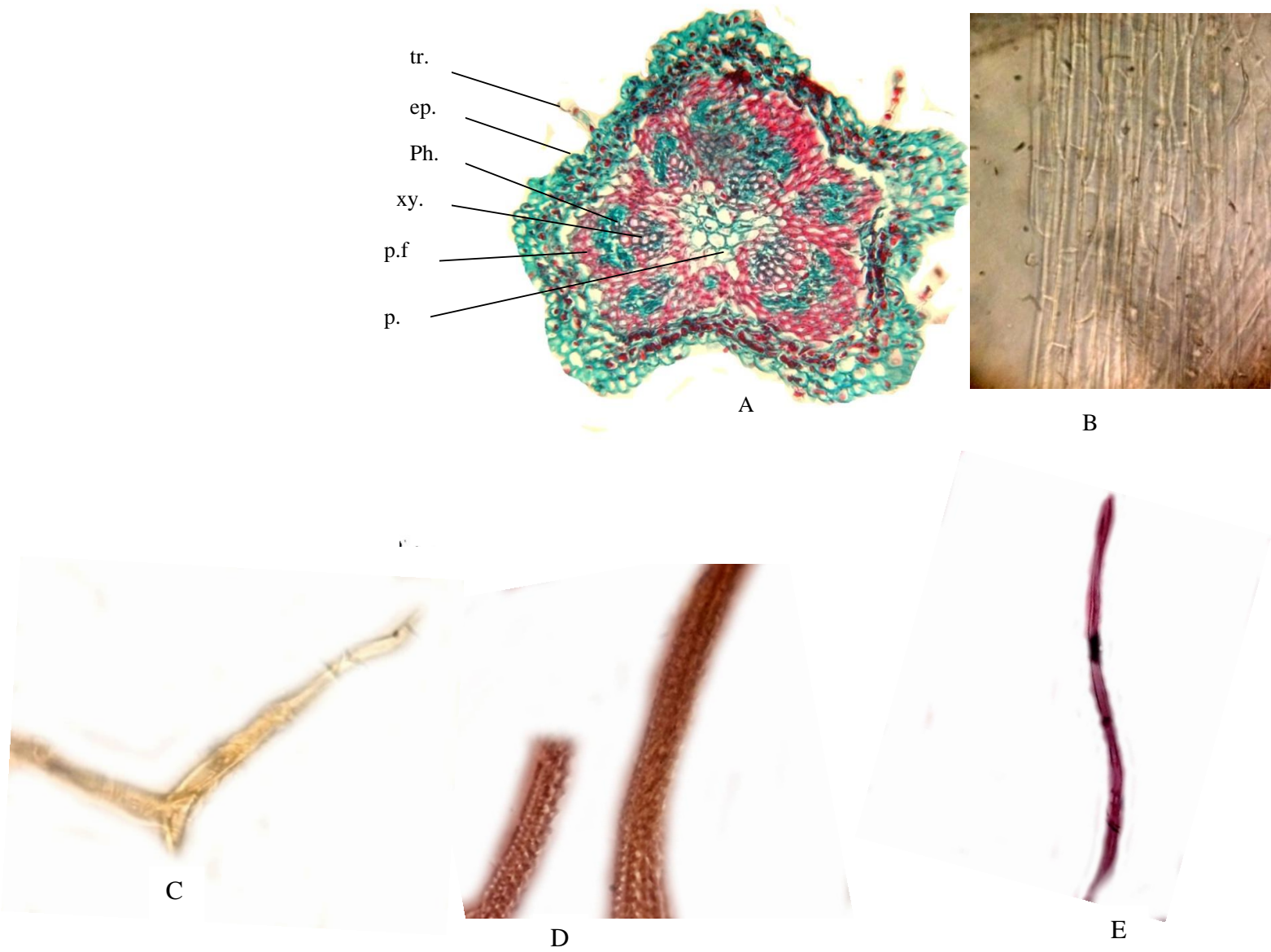


Fig. (11): The peduncle:

A-Diagrammatic transverse section of peduncle (2857 x)

B- Epidermal cells (268.8 x)

C- T-shaped hair. (224.2 x)

D-Vessels. (641 x)

E- Pericyclic fibers. (964 x)

ep., epidermis; p., pith; p.f., pericyclic fiber; ph., phloem; tr., trichome; v., vessel; xy., xylem.

6- The rhizome

Transverse section of the rhizome (Fig.12A&12B) is circular in outlines. It shows externally a cork followed by parenchymatous cortex. The vascular system is composed of a central cylinder of vascular elements, formed of a narrow phloem enclosing a cylinder of radiating xylem with a central parenchymatous pith.

Cork: (Fig. 13A)

The cork is formed of 4 to 6 radially arranged rows of tangentially elongated cells with suberized, slightly lignified walls with no intercellular spaces and measure 33.5 to 67 μm in length, 27.9 to 44.6 μm in breadth. In surface view, the cells are polygonal with straight anticlinal wall.

Cortex:

The cortex is composed 10 to 20 layers of parenchymatous cells with thin-cellulosic walls and narrow intercellular spaces measuring 13.4 -39.1 μm in diameter, packed with reserve materials and rosettes of Ca oxalate measuring 11.17-20.11 μm in diameter. Several Schizogenous glands forming diffuse ring at the lower layers of the cortex, they are rounded or oval in outline measuring 39-55.8 μm in diameter and filled with dark content. The endodermis is indistinguishable.

Vascular tissue:

The vascular tissue (Fig. 12A) is formed of 10 – 12 collateral vascular bundles arranged in a ring and separated by wide medullary rays. Each vascular bundle consists of xylem inward and phloem outward.

Phloem:

The phloem is formed of sieve tubes with companion cells and phloem parenchyma and phloem fibers were detected they measure 5.5 – 8.9 μm in diameter. Phloem parenchyma is polygonal, thin walled cellulosic cells.

Xylem:

The xylem consists mainly of vessels, numerous wood fibers and wood parenchyma. The vessels (Fig.13E) are radially arranged, few are solitary, has spiral, annular and pitted thickening and measure 5.5 – 22.3 μm in diameter.

The wood fibers (Fig.13D) are spindle-shaped with thick, pitted lignified walls, narrow lumen and blunt apices. They measure 391 - 558.7 μm in length and 10 – 16.7 μm in diameter. The wood parenchyma (Fig.13 B) consist of polygonal, rectangular usually axially elongated cells with lignified, thick pitted walls, showing simple pits and measure 18.3–30.6 μm in length and 1.2-3.1 μm in breadth.

The pith:

The pith consists of relatively large polygonal parenchyma cells which tend to decrease in size towards the periphery some of them contain rosettes of ca.oxalate of 11.5-20.11 μm in diameter.

7- The root

Transverse section of the root (Fig.14 A, B) appears circular in outline. It shows an outer cork surrounding a narrow parenchymatous cortex lined internally with well differentiated endodermis. The pericycle is collenchymatous with isolated groups of sclereid surrounding a wide cylinder of vascular tissue with tetrarch primary xylem in the center. phelloderm, the pericycle shows groups of lignified fibers. The cambium is well differentiated. The medullary rays are distinguished.

Cork:

The cork is formed of 2- 3 rows of brownish somewhat tangentially elongated cells. In surface view (Fig. 14 C) the cells are subrectangular with non-lignified walls and measuring 33.5 - 67.5 μm in length, 22.3 - 33.5 μm in breadth.

Cortex:

The secondary cortex (Fig.14 B) is formed of 2- 4 rows and consists of thin

walled tangentially elongated, sub rectangular to polygonal parenchymatous cells.

Pericycle:

The pericycle (Fig. 14 A&B) consists of collenchyma interrupted by groups of pericyclic sclereids which have thick lignified walls with simple pits, narrow lumen. They measure 33.45 – 76.58 μm in length.

Vascular system:

The vascular system is formed of thin-walled, soft cellulosic phloem elements, composed of sieve tubes, companion cells and phloem parenchyma.

The cambium is distinguishable and represents of 2-3 rows of brick like thin-walled cells between the xylem and outer phloem and extend between the vascular bundles forming the interfascicular cambium.

The xylem (Fig.14D) is wide, wholly lignified and consists of isolated vessels or in groups, wood fibers and wood parenchyma. The vessels have pitted thickening and measuring 11.1-56 μm in diameter.

Wood fibers (Fig.14G) are groups of radial rows having thin or thick lignified walls with acute ends and measure 290.5 - 502.7 μm in length and 4.46 - 11.1 μm in diameter. The pitted wood parenchyma

(Fig.15G) is formed of rectangular cells with moderately thick lignified walls and measure 4.5 to 13.4 μm in diameter.

The medullary rays (Fig. 14 A& B) are multiseriate and formed of cellulosic, subrectangular cells which measure 11 - 33.5 μm in length and 4.4 to 10 μm in breadth.

The Powdered root:

The powdered root is yellowish-brown in colour having faint characteristic odour and slight salty taste. It is characterized microscopically by the following fragments:

- 1- Fragments of brown, non-lignified, thin walled polygonal mostly subrectangular, sometimes isodiametric cork cells.
- 2- Fragments of thin walled parenchymatous cells from the cortex.
- 3- Fragments of soft cellulosic and parenchymatous phloem cells.
- 4- Fragments of lignified pitted xylem vessels.
- 5- The wood fibers usually straight or slightly irregular outline with narrow and wide lumen, lignified walls and acute apices.
- 6- The wood parenchyma cells are pitted consisting of rectangular cells with lignified walls.

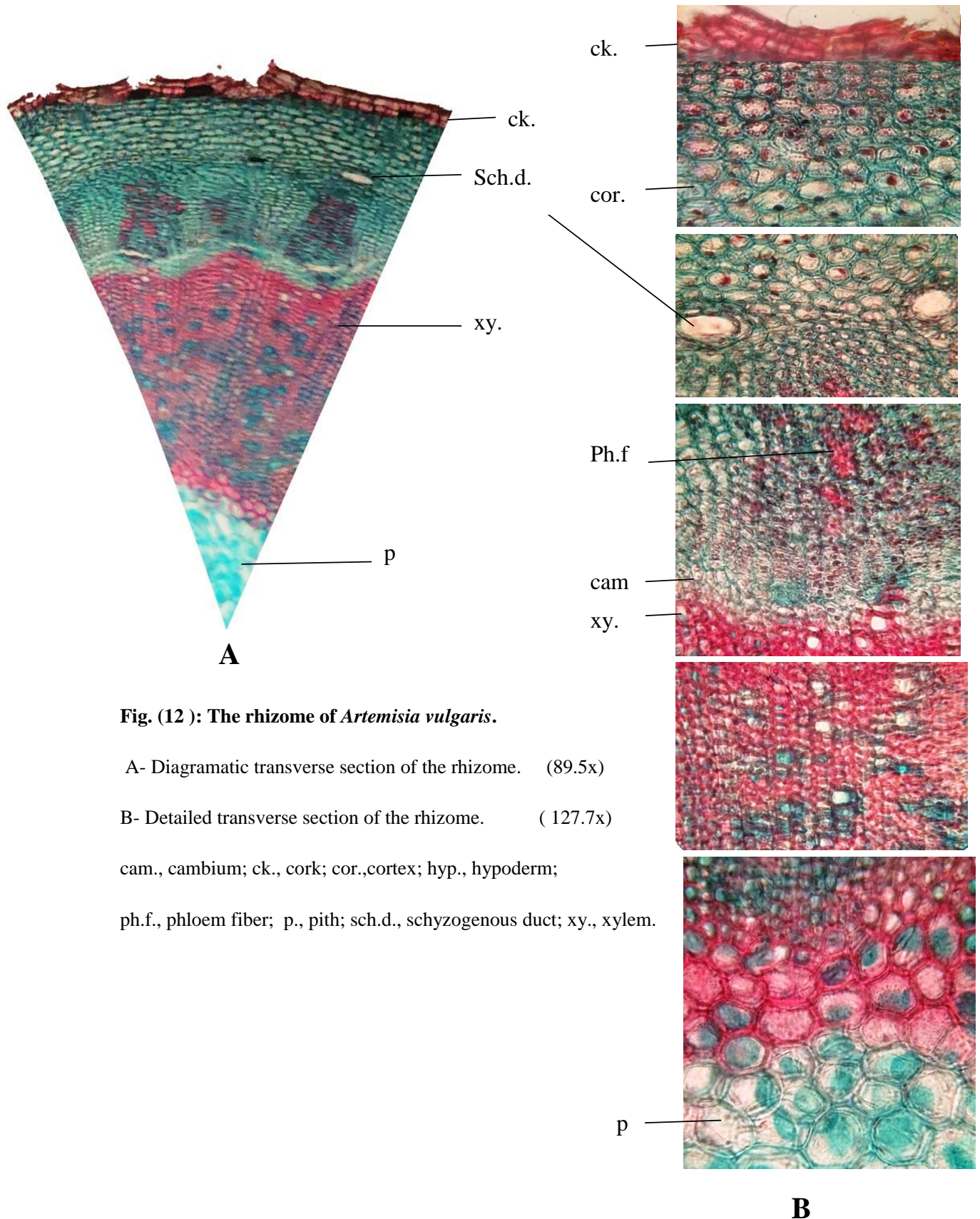


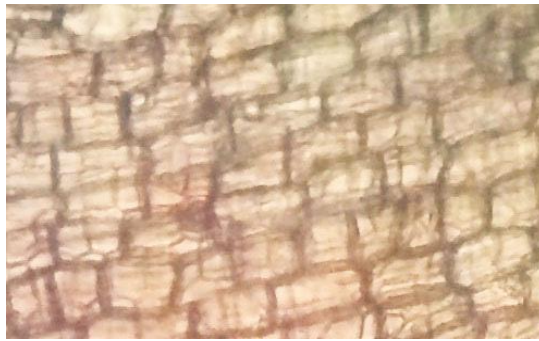
Fig. (12): The rhizome of *Artemisia vulgaris*.

A- Diagrammatic transverse section of the rhizome. (89.5x)

B- Detailed transverse section of the rhizome. (127.7x)

cam., cambium; ck., cork; cor., cortex; hyp., hypoderm;

ph.f., phloem fiber; p., pith; sch.d., schizogenously duct; xy., xylem.



A



B



C



D



E



F

Fig. (13): The rhizome elements of *Artemisia vulgaris* L.

- | | |
|----------------------------|----------|
| A- Cork cells. | (221.5x) |
| B- Wood parenchyma. | (980.3x) |
| C- Tracheids | (241.8x) |
| D- Fibers | (179x) |
| E- Xylem vessel | (224.2x) |
| F- Rosettes of Ca oxalate. | (298.3x) |



Fig. (14) The root:

A-Diagrammatic transverse section of the root.	(224.7x)
B-Detailed transverse section of the root.	(1123.7x)
C-Cork cells in surface view	(223.7x)
D-Vessels.	(454.5x)
E- Wood parenchyma	(268.5x)
F- Sclereid.	(135.1x)
G-Wood fibers.	(239x)

cam., cambium; ck., cork; cor.,cortex; m.r., medullary ray; p.scl., pericyclic sclereid; ph., phloem; v., vessel.

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دراسة عيانية و مجهرية لنبات ارتيميزيا فاجارز ال من العائلة المركبة والنامى فى مصر

نوال فراج - داليا ابراهيم حمدان - وفاء محمد اسماعيل.

قسم العقاقير - كلية الصيدله - جامعة الزقازيق - مصر

فى هذا البحث تمت دراسة الصفات العيانية والمجهرية لنبات ارتيميزيا فاجارز (العائلة المركبه) متضمنة الاجزاء الهوائية من الاوراق والساق والزهور والاجزاء الجذرية والريزومات ايضا للتعرف على النبات فى حالته الصحيحة او مسحوقا